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OHIO RIVER ODOR STUDIES

F. M. Middleton

Public Health Service
Cincinnati, Ohio

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Ohio River Odor Studies

September through December 1950

F. M. Middleton

The purpose of this study, the methods of conducting it and the results for the month of August 1950 have been described in an earlier report. The present report includes data obtained on the standard odor substance, on raw water and on finished water for the period from September through December 1950.

The proper interpretation of threshold tests requires consideration of several factors. In making the test, the observer records the presence of any odor, objectionable or pleasant. Hence, a water may show a high threshold number yet not be particularly difficult to treat for the removal of taste and odor. Again, certain materials may produce very objectionable tastes and odors and relatively low threshold numbers may be recorded. On finished waters, the residual chlorine or the "chlorine odor" varies widely from plant to plant. A chlorinous odor may be quite strong to an experienced observer yet the water consumers may not complain because they are accustomed to the odor or taste and do not find it objectionable.

The plant operator soon learns to combine a knowledge of the threshold number and the qualitative characteristics of the water to provide the best treatment for combating tastes and odors. Under severe conditions the tastes and

odors on the Ohio River may go through any normal treatment methods and reach the consumers.

The cities on the Ohio River did not experience much trouble with tastes and odors from September through November. An extremely heavy snow covered the valley in late November. The first part of December this snow melted and along with rain caused the river to reach flood stage. From East Liverpool to Cincinnati, most cities experienced the worst tastes and odors encountered for many months. Following the peak stage of the river, odors dropped slowly. Cities below Cincinnati did not experience this condition to the same extent that up-river cities did. Similar observations have been made under other rising river conditions.

Detailed data on the standard odor substance are included in Tables I through IV. It is interesting that the greatest number of observations were made at a 1/4 p.p.m. concentration of the normal butyl alcohol. The distribution of the observations for the entire period follows the normal distribution curve fairly well being skewed somewhat to the left.

Results of observations on raw water, both corrected and uncorrected, are presented in detail in Tables V through VIII and graphically in Figures 1 through 4. The geometric mean threshold values on finished water are shown in Table IX.

Observations made by actual visitation and from a study of the reports for each cooperating plant are presented in the remainder of this report.

East Liverpool, Ohio

Raw water threshold numbers ranged around 5 to 7 (10-25 corrected) from September through December. Odors were described as chemical, hydrocarbon, phenol, aromatic and musty. For a period of one or two days, late in November, the large industries were closed due to the heavy snowfall. The operator noted a sewage odor at this time and no chemical odor.

Finished water threshold numbers were quite low. Frequently no odor was detected in the undiluted sample and on no occasion did the operator detect less than the 100 ml. dilution.

Weirton, West Virginia

The highest threshold numbers on the Ohio River were recorded at Weirton. The range on the raw water was from 28 to 71 (81 to 141 corrected). The most difficulty in the odors was experienced in early December and late December. Mr. DeFranco used a combination of aeration, chlorine dioxide and activated carbon to control the odor.

The mean threshold for the month of December was not as large as other mean thresholds for other months. The

quality of the material causing the difficulty was obviously different. Types of odors reported include sewer gas, phenolic, disagreeable, varnish, styrene, earthy, stagnant and musty. At the time of greatest difficulty, Mr. DeFranco reported the odor in both hot and cold solutions as varnish-like. It is interesting that a number of samples of organic extract obtained from various water supplies along the Ohio also have this varnish-like characteristic odor.

Although this report does not include data after December, a look ahead at Weirton's January and February data show a most unusual drop in odor intensity beginning about January 8 and continuing to about the middle of February. A threshold of one or two was recorded on most of these days.

The finished water at Weirton has been remarkably good considering the condition of the raw water. Threshold numbers were four or less at all times although a very complete treatment was sometimes necessary to maintain this condition. During the worst period, some taste and odor got to the consumers but this was quickly corrected.

Wheeling, West Virginia

Odor intensities decreased from the high values at Weirton to a range of 4 to 17 (16 to 33 corrected). December again appeared to be the worst month for tastes and odors at Wheeling. The finished water showed an increased

threshold value from September through December, the range being 1 to 14 (6 to 30 corrected). The principal qualitative description of the odor at Wheeling was muddy or grassy.

Pomeroy, Ohio

The threshold values on the raw water ranged from 9 to 28 for the period of September through December. Due to Mr. Stephenson's consistent observation of the standard, little correction was required. The lowest odor intensities were recorded in October, the highest in December. As with most other up-river cities, Pomeroy experienced some odor difficulty in December. Additional chlorine dioxide brought the odors under control and the trouble was relatively short-lived. Raw water odors were variously described as sweet, phenolic, musty and mouldy.

Nitro, West Virginia

The raw water at Nitro (Kanawha River) is very odorous. Threshold numbers on the raw water ranged from 36 to 135 (128 to 580 corrected).

The highest average threshold occurred in October. The principal types of odors at Nitro were described as chemical, alcohol, styrene and similar aromatic types. Musty or phenolic odors appear to be largely absent.

The finished water threshold numbers ranged from 3 to 13 (11 to 27 corrected). The odor of the finished water is sweetish or alcoholic for the most part. Activated carbon is used routinely at Nitro to help reduce the odor.

Ashland, Kentucky

Results for Ashland are for November and December only. The raw water had threshold values of 8 to 11 (24 to 47 corrected). It will be noted that the odor is up appreciably compared to that recorded at Pomeroy. The raw water at Ashland has a definite odor of kerosene or oil.

Finished water at Ashland was maintained at threshold values of one or two for the most part. Carbon is used in small amounts routinely at Ashland. While most up-river cities experienced difficulty in December, Ashland did not report any unusual conditions.

Portsmouth, Ohio

The raw water at Portsmouth appears to be rather consistent. The threshold numbers of the raw water ranged from 3 to 9 (7 to 18 corrected). In December, the highest thresholds recorded (64) occurred for seven or eight days. Immediately after this period, thresholds dropped to two or four and remained at that level.

Finished water thresholds were reported as being one or less. The operator attempts to report only non-chlorinous odors in these tests.

Cincinnati, Ohio

The geometric mean threshold values of the raw water at Cincinnati varied from 3 to 12 (6 to 25 corrected). During December, serious tastes and odors appeared in the Cincinnati

water. The regular break-point chlorination treatment did not eliminate all of this taste and odor. The objectionable quality of the particular substances causing the trouble was not reflected in the threshold values as higher values were obtained in September when no particular trouble was experienced with tastes and odors.

Finished water thresholds ranged from two to five. The principal odor in the finished water is chlorinous.

Louisville, Kentucky

The raw water at Louisville has had consistently low threshold values (1 to 4). No odor trouble was experienced at Louisville, during the period in December when cities further up-river were having bad odor conditions. This may be accounted for by the dilution and the fact that a long stretch of river occurs between Cincinnati and Louisville with a relatively small amount of pollution. However, at various times in the past two or three years, Louisville had had sporadic tastes and odors. The raw water odor are variously described as musty, woody, pungent, muddy, oily, fishy, chemical, alcohol and solvent. Even though low thresholds are the general rule at Louisville, it appears that a narrow margin exists between suitable water and unsatisfactory water.

The finished water had threshold values of one or

less during the September through December period. Consumers, accustomed to very palatable water most of the time are likely to complain when a slight taste and odor occurs.

New Albany, Indiana

The raw water at New Albany varied from two to four in terms of threshold units. The operator at New Albany usually detects 1/16 p.p.m. of the standard and the corrected thresholds are lower than the uncorrected. No complaints are noted at New Albany. The raw water has at times had an aromatic somewhat perfume-like odor.

Finished water thresholds are usually one or two.

Finished water thresholds are usually one or two.

The operator ordinarily dechlorinates the tap water prior to making the odor test.

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Evansville, Indiana

Threshold numbers on the raw water at Evansville ranged from 14 to 33 for the period under consideration. Due to consistent observations on the standard, the uncorrected and corrected values are nearly identical. The odors described in the raw water include musty, aromatic, and hydrocarbon. The odors were about two times as intense in September and December as in October and November.

Finished water thresholds appear higher than might

be expected. This is largely due to the high chlorine residual leaving the plant at Evansville. The operator records the presence of any odor and the chlorinous odor can be detected in rather small amounts. This odor is not objectionable to the consumer as few if any complaints occur. Tests are soon to be made on dechlorinated tap samples and comparison can then be made of the odors in water free from chlorine.

Cairo, Illinois

Cairo, at the mouth of the Ohio, has not had any appreciable taste and odor problems in the months of November and December, the period for which data has been received.

The raw water had threshold values of 3 (11 to 2¼ corrected). Odors were characterized as musty, phenol and fishy.

The finished water at Cairo is remarkably good and no odor was detected in most tests. Little difference was noted in the odor before or after chlorination.

Youngstown, Ohio

Youngstown is serving as a control point in this study. The source of the water is Meander Creek and a 10 billion gallon impoundment reservoir provides storage. The water is believed to be free from industrial wastes. It is frequently difficult to detect the difference between

the raw water and the odor free water at 30°C. At 60°C. the difference is more distinct. Threshold numbers at 30°C. on the raw water were one (1 to 4.6 corrected). The raw water odor is described as musty and the finished water is described as having a grassy odor.

Threshold numbers on the finished water are about equal to those on the raw water. The odor, though low in intensity, may cause some complaint in hot water. Such low residual odors are often difficult to remove.

Columbus, Ohio

The impounded water of the Scioto River serves as a source of water for Columbus. The watershed is principally in an agricultural area. Columbus was chosen as a control point for this study.

The threshold values on the raw water were approximately one on the uncorrected basis. The observer at Columbus had a rather high factor on the standard odor and corrected thresholds were approximately 18 or 19 for November and December. The odor is usually described as musty and a few times an oily odor was noted.

The finished water showed corrected threshold of 16 to 20 for the months of November and December.

Personnel Cooperating in the Study

City	Name	Position
East Liverpool, Ohio	Donald T. Duke	Superintendent and Chemist
Weirton, West Virginia	F. J. DeFranco	Superintendent and Chief Chemist
	L. Enretti	Operator
	D. Ridgeway	Operator
Wheeling, West Virginia	A. R. Todd	Superintendent
	C. Kalo	Operator
Pomeroy, Ohio	J. M. Stephenson	Chief Engineer
Nitro, West Virginia	T. F. Blair, Jr.	President, West Virginia Water Service Company
	Wallace Grant	Chief Chemist
	M. L. Mullins	Chemist
Ashland, Kentucky	J. P. Brownstead	Manager
	C. Keaton	Chemist
Portsmouth, Ohio	H. C. Growdon	Superintendent and Chemist
Cincinnati, Ohio	W. B. Evans	Superintendent
	D. Enright	Assistant Superintendent
	B. Shuey	Chemist
	W. Kispert	Chemist
Louisville, Kentucky	J. H. Lovejoy	Superintendent
	W. L. Williams	Chemist
	H. S. Jenkins	Engineer

New Albany, Indiana	C. H. Wooly	Superintendent
	S. Ginther	Chemist
Evansville, Indiana	O. W. Summers	Superintendent
	L. Killian	Chemist
	P. Barning	Chemist
Cairo, Illinois	H. L. Hileman	Manager
	Ward Karraker	Chief Chemist
	Leo Wilson	Chemist
Youngstown, Ohio	William I. VanArmum	Chief Chemist
	George Tshman	Bacteriologist
Columbus, Ohio	Paul Laux	Superintendent
	Willard Harper	Chief Chemist
	Richard Melick	Chemist

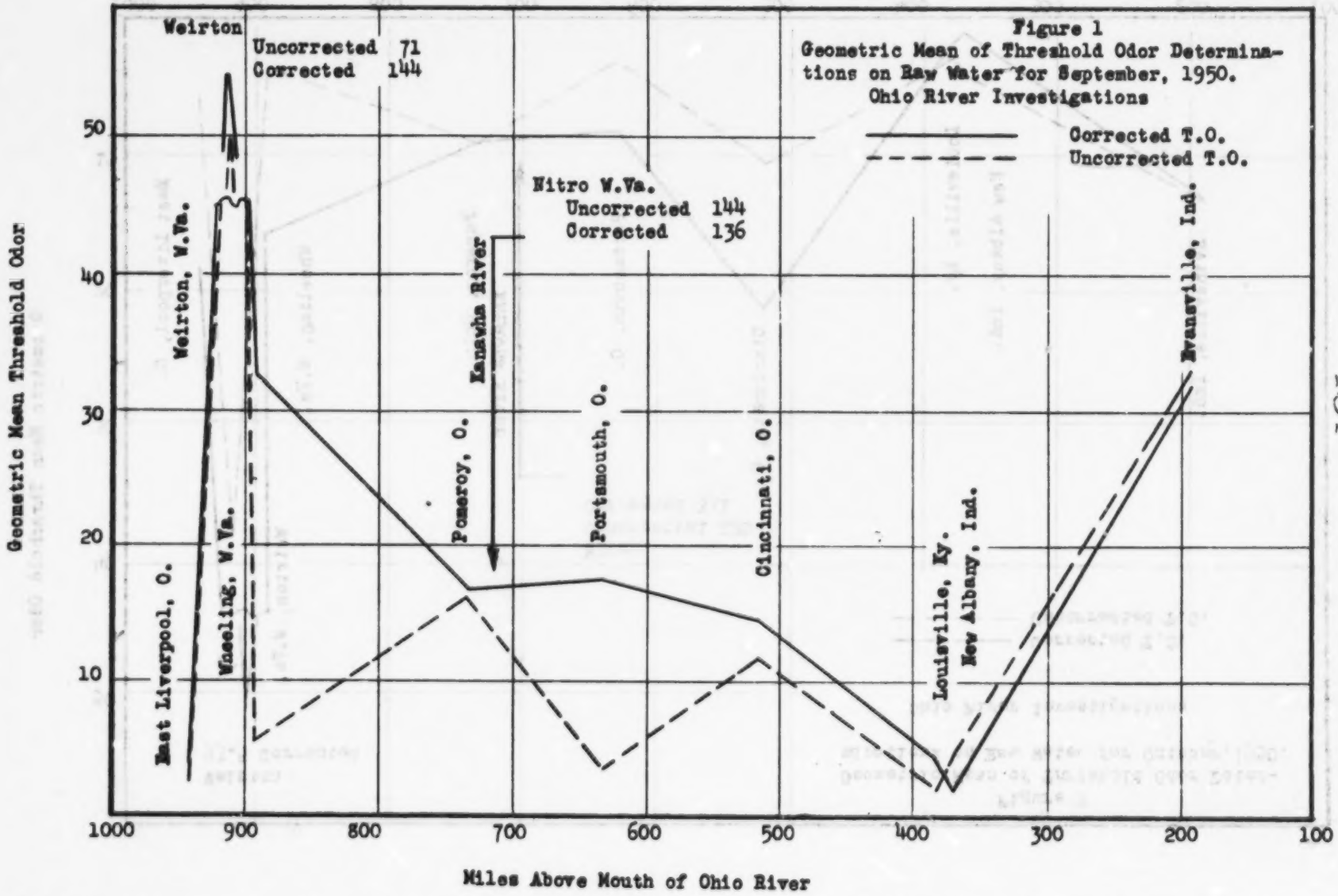

Figure 1
Geometric Mean of Threshold Odor Determinations on Raw Water for September, 1950.
Ohio River Investigations

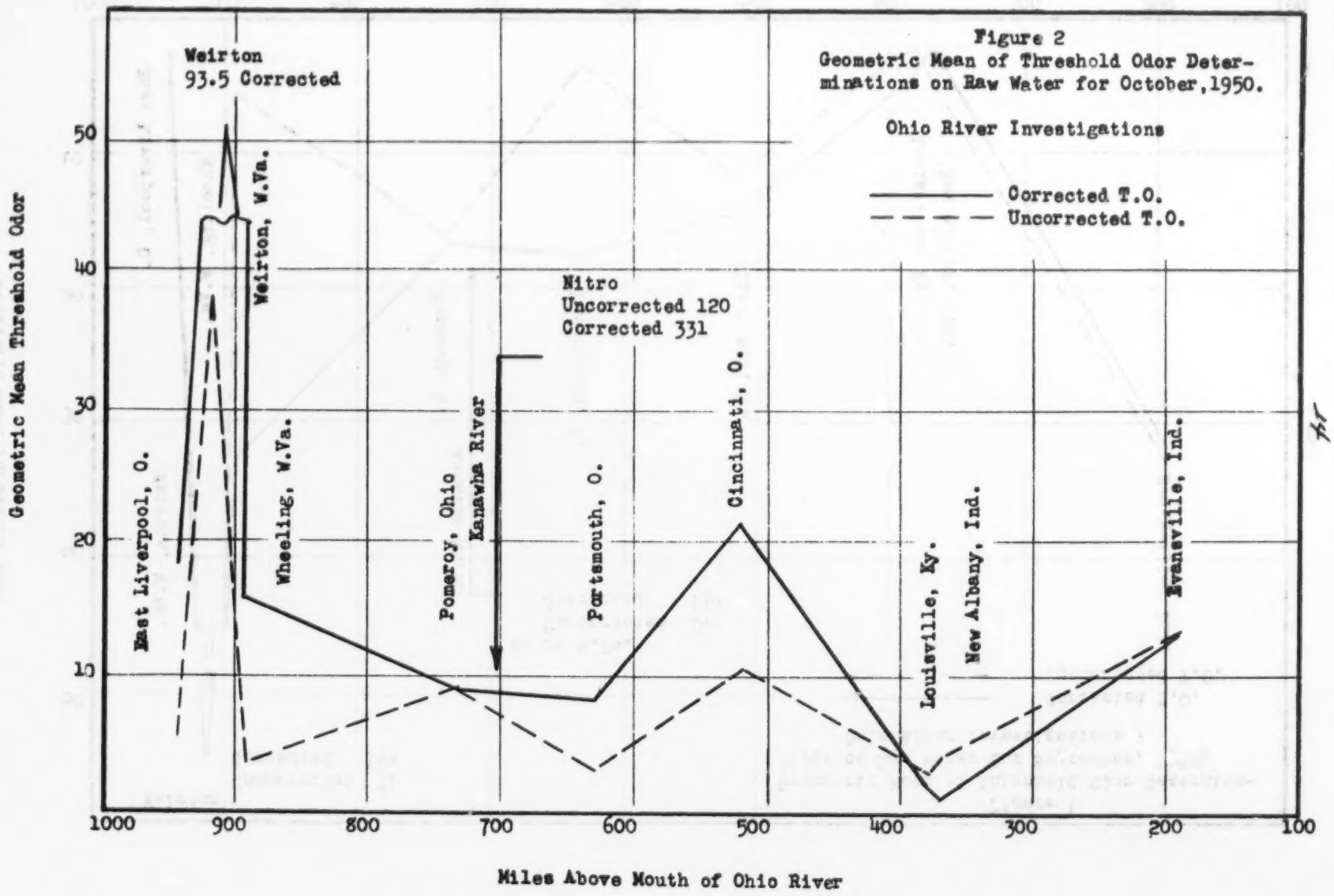
Figure 2
Geometric Mean of Threshold Odor Determinations on Raw Water for October, 1950.
Ohio River Investigations
Corrected T.O.
Uncorrected T.O.
Weirton
93.5 Corrected
Nitro
Uncorrected 120
Corrected 331
Geometric Mean Threshold Odor
50
40
30
20
10
East Liverpool, O.
Weirton, W.Va.
Wheeling, W.Va.
Pomeroy, Ohio
Kanawha River
Portsmouth, O.
Cincinnati, O.
Louisville, Ky.
New Albany, Ind.
Evansville, Ind.
1000
900
800
700
600
500
400
300
200
100
Miles Above Mouth of Ohio River

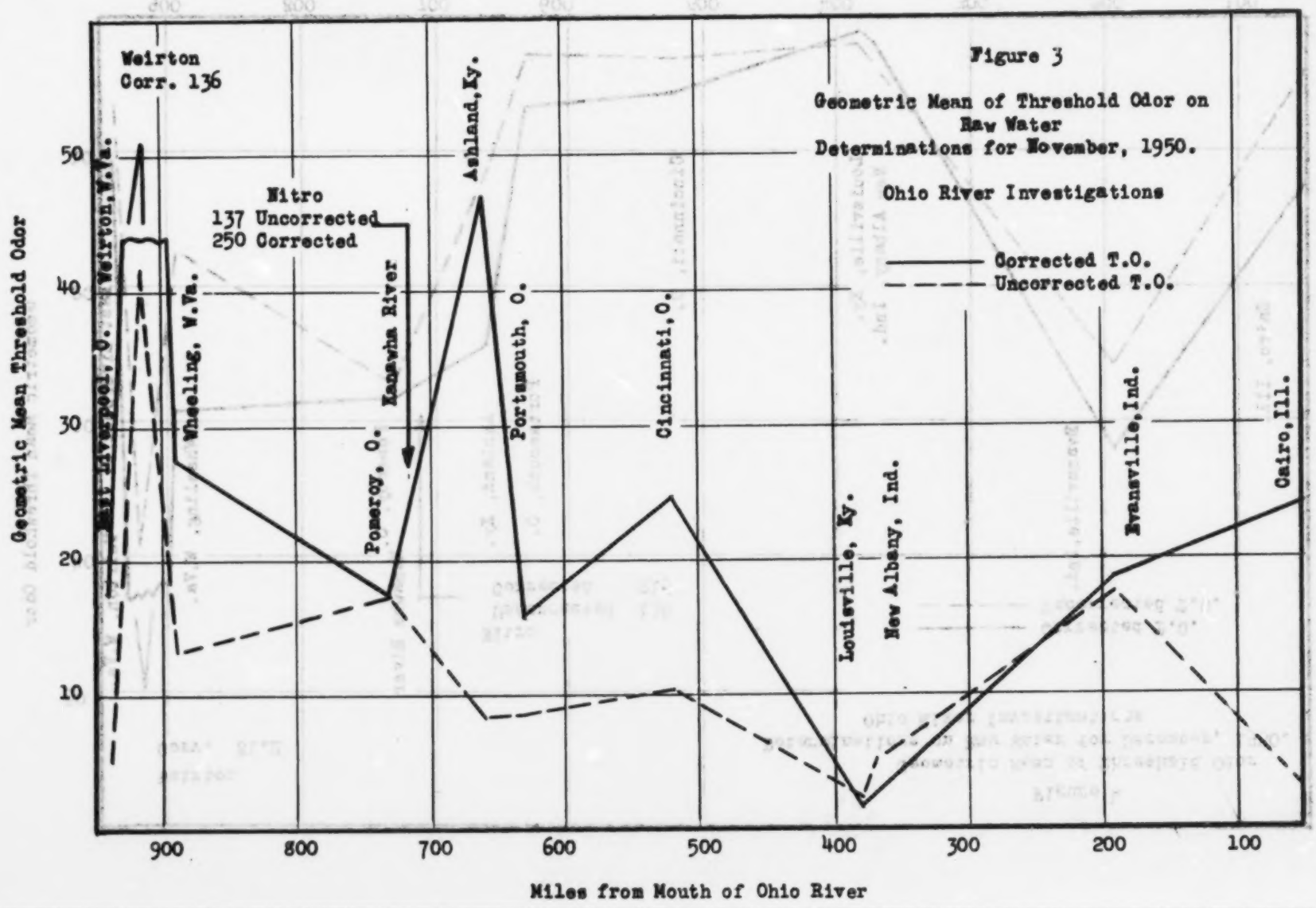
Figure 3
Geometric Mean of Threshold Odor on Raw Water Determinations for November, 1950.
Ohio River Investigations
Corrected T.O.
Uncorrected T.O.
Weirton Corr. 136
Nitro
137 Uncorrected
250 Corrected
Weirton, W.Va.
Mill Liverpool, O.
Wheeling, W.Va.
Pomeroy, O.
Kanawha River
Ashland, Ky.
Portsmouth, O.
Cincinnati, O.
Louisville, Ky.
New Albany, Ind.
Evansville, Ind.
Cairo, Ill.
Geometric Mean Threshold Odor
50
40
30
20
10
900
800
700
600
500
400
300
200
100
Miles from Mouth of Ohio River

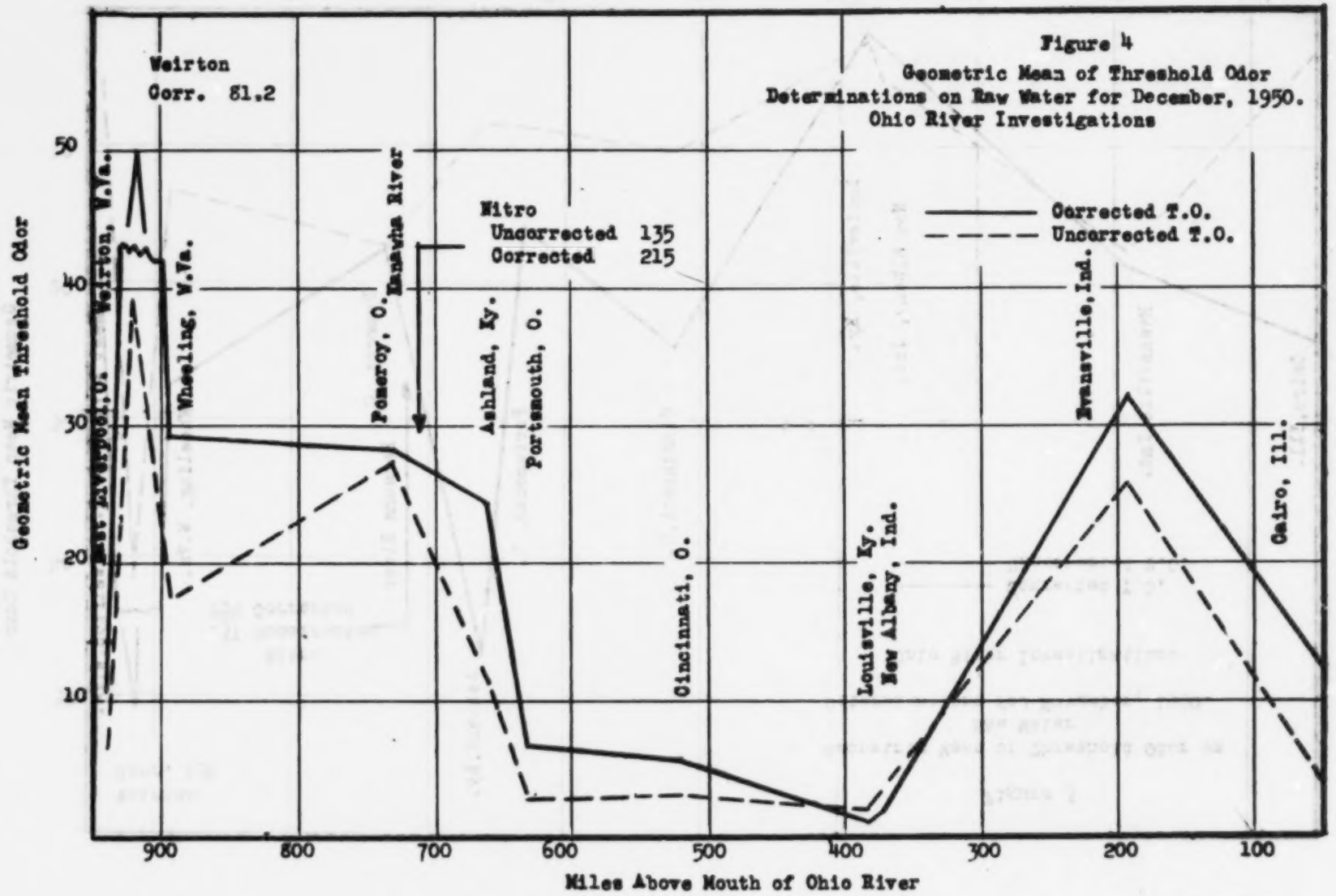
Figure 4
Geometric Mean of Threshold Odor
Determinations on Raw Water for December, 1950.
Ohio River Investigations
Weirton
Corr. 81.2
Nitro
Uncorrected 135
Corrected 215
Corrected T.O.
Uncorrected T.O.
Geometric Mean Threshold Odor
50
40
30
20
10
East Liverpool, O.
Weirton, W.Va.
Wheeling, W.Va.
Pomeroy, O.
Kanawha River
Ashland, Ky.
Portsmouth, O.
Cincinnati, O.
Louisville, Ky.
New Albany, Ind.
Evansville, Ind.
Cairo, Ill.
900
800
700
600
500
400
300
200
100
Miles Above Mouth of Ohio River

TABLE I - COMPARISON OF OBSERVER'S ABILITIES TO DETECT STANDARD ODOR IN WATER SOLUTION AT 30°C. - OHIO RIVER INVESTIGATION, SEPTEMBER 1950

Station	Number of Times Minimum Standard Odor Detected Was Indicated Concentration (p.p.m.)							Observer's Odor Factor (a)			Number of
	1/16	1/8	1/4	1/2	1	2	4	Ave.	Max.	Min.	Determ.
Ashland, Ky.				No Data							
Cairo, Ill.				No Data							
Cincinnati, O.	2	2	5					1.4	2	1/2	9
Columbus, O.				No Data							
East Liverpool, O.			9	8				2.8	4	2	17
Evansville, Ind.	1	19						1.0	1	1/2	20
Louisville, Ky.		8	6	5	1			2.4	8	1	20
New Albany, Ind.		10						1.0	1	1	10
Nitro, West Va.			3	11				3.6	4	2	14
Pomeroy, Ohio		21	1					1.0	2	1	22
Portsmouth, Ohio			4	8	13			5.8	8	2	25
Weirton, W. Va.		1	19	1				2.0	4	1	21
Wheeling, W. Va.				7	12			6.5	8	4	19
Youngstown, Ohio			3	1	1			3.6	8	2	5
For All Data	3	61	50	41	27						182

(a) Odor Factor = 8 (Concentration in p.p.m. of minimum standard odor detected.)

TABLE II - COMPARISON OF OBSERVER'S ABILITIES TO DETECT STANDARD ODOR IN WATER SOLUTION AT 30°C. - OHIO RIVER INVESTIGATION, OCTOBER 1950

Station	Number of Times Minimum Standard Odor Detected Was Indicated Concentration (p.p.m.)							Observer's Odor Factor (a)			Number of Determ.
	1/32	1/16	1/8	1/4	1/2	1	2	Ave.	Max.	Min.	
Ashland, Kentucky				No Data							
Cairo, Illinois				No Data							
Cincinnati, Ohio			1	5	1			2.1	4	1	7
Columbus, Ohio							1	16	16	16	1
East Liverpool, Ohio				7	12	2		3.7	8	2	21
Evansville, Indiana			20					1	1	1	20
Louisville, Ky.	3	9	5	1		1		.8	8	1/4	19
New Albany, Indiana		12	6					.6	1	1/2	18
Nitro, West Virginia			3	3	3	2		3.4	8	1	11
Pomeroy, Ohio			14					.5	1	1	14
Portsmouth, Ohio			1	10	5	9		3.4	8	1	25
Weirton, W. Va.			1	18	3			2.2	4	1	22
Wheeling, W. Va.					11	1		4.3	8	4	12
Youngstown, Ohio				1	6	2	1	5.6	16	2	10
For All Data	3	21	45	42	39	15	2				169

(a) Odor Factor = 8 (Concentration in p.p.m. of Minimum Standard Odor Detected).

TABLE III - COMPARISON OF OBSERVER'S ABILITIES TO DETECT STANDARD ODOR IN WATER SOLUTION AT 30°C. - OHIO RIVER INVESTIGATION, NOVEMBER 1950

Station	Number of Times Minimum Standard Odor Detected Was Indicated Concentration (p.p.m.)							Observer's Odor Factor (a)			Number of Determ.
	1/16	1/8	1/4	1/2	1	2	4	Ave.	Max.	Min.	
Ashland, Ky.			5	6	2	3	2	9.0	32	2	18
Cairo, Ill.			2	2	8	9		10	16	2	21
Cincinnati, O.	2	2	5					1.4	2	1/2	9
Columbus, O.						7	1	18	32	16	8
East Liverpool, O.			7	11				3.2	4	2	18
Evansville, Ind.		16	2					1.1	2	1	18
Louisville, Ky.		8	6	5	1			2.4	8	1	20
New Albany, Ind.	18	1						0.5	1	1/2	19
Nitro, W. Va.		2	2	2				2.3	4	1	6
Pomeroy, O.		9	6					1.4	2	1	15
Portsmouth, O.		10	10	6				2.0	4	1	26
Weirton, W. Va.		1	17	4				2.3	4	1	22
Wheeling, W. Va.			9	7				2.9	4	2	16
Youngstown, O.			2	4	3	1		7.6	32	2	10
For All Data	20	49	73	47	14	20	3				226

(a) Odor Factor = 8 (Concentration in p.p.m. of Minimum Standard Odor Detected.)

TABLE IV - COMPARISON OF OBSERVER'S ABILITIES TO DETECT STANDARD ODOR IN WATER SOLUTION AT 30°C. - OHIO RIVER INVESTIGATION, DECEMBER 1950

Station	Number of Times Minimum Standard Odor Detected Was Indicated Concentration (p.p.m.)							Observer's Odor Factor (a)			Number of Determ.
	1/16	1/8	1/4	1/2	1	2	4	Ave.	Max.	Min.	
Ashland, Ky.				8	11			6.3	8	4	19
Cairo, Ill.		1	6	5	5		1	5.6	32	1	18
Cincinnati, O.	1	2	4	2				2.0	4	1/2	9
Columbus, O.						5		16.0	16	16	5
East Liverpool, O.			15					2.0	2	2	15
Evansville, Ind.		14	3	1				1.3	4	1	18
Louisville, Ky.	13		1					0.8	2	1/2	14
New Albany, Ind.	18	2						0.5	1	1/2	20
Nitro, W. Va.		2		1				3.3	4	1	3
Pomeroy, O.	1	17	2					1.1	2	1/2	20
Portsmouth, O.			17	7				2.6	4	2	24
Weirton, W. Va.			20	1				2.1	4	2	21
Wheeling, W. Va.		5	10	1				1.8	4	1	16
Youngstown, O.				4	1			6.4	8	4	5
For All Data	33	43	78	30	17	5	1				197

(a) Odor Factor = 8 (Concentration in p.p.m. of minimum standard odor detected.)

TABLE V - RESULTS OF THRESHOLD ODOR DETERMINATION ON RAW OHIO RIVER WATER AT 30°C. - OHIO RIVER INVESTIGATIONS, SEPTEMBER, 1950

Location			Threshold Odor of Raw River Water													
			Number of Occurrences of Indicated Threshold Odor													
Miles From Mouth of River	Station		0	1	2	4	8	16	32	64	128	256	512	1024	Geom. Mean.	Number of Determ.
940.8	East Liverpool, O.	U*			1	3	12	1							6.3	
		C**				1	1	9	5	1					25	17
918.5	Weirton, W. Va.	U.							3	12	6				71	
		C.								2	14	5			141	21
894.2	Wheeling, W. Va.	U.				11	8								5.4	
		C.						4	10	5					33	19
732.7	Pomeroy, Ohio	U.					5	11	6						16.5	
		C.					5	10	7						17.0	22
715.3 +K44.2	Nitro, W. Va.	U.					1	4	1	7	1				36.8	
		C.							1	4	3	6			128	14
661.1	Ashland, Kentucky	U.														
		C.					No	Data								
630.1	Portsmouth, Ohio	U.			13	10	7								3.5	
		C.					4	18	7	1					17.8	30
518.2	Cincinnati, Ohio	U.			1		1	7							11.8	
		C.				1	2	3	3						14.7	9
380.5	Louisville, Ky.	U.			17	3									2.2	
		C.			8	4	6	2							4.2	20
372.6	New Albany, Ind.	U.			1	7	2								4.3	
		C.			1	7	2								4.3	10
189.4	Evansville, Ind.	U.					2	2	10	5	1				33	
		C.					2	2	11	4	1				32	20
4.5	Cairo, Illinois	U.														
		C.					No	Data								
Scioto River	Columbus, Ohio	U.														
		C.					No	Data								
Meander Creek	Youngstown, Ohio	U.	1	3	1										1.0	
		C.	1	0	1	2	1								1.6	10

*Uncorrected

**Corrected

Table VI - RESULTS OF THRESHOLD ODOR DETERMINATIONS ON RAW RIVER WATERS AT 30°C. - OHIO RIVER INVESTIGATIONS, OCTOBER, 1950

Location			Threshold Odor of Raw River Water													
			Number of Occurrences of Indicated Threshold Odor													
Miles From Mouth of River	Station		0	1	2	4	8	16	32	64	128	256	512	1024	Geom. Mean	Number of Determ
940.8	East Liverpool, O.	U.*			3	8	8	2							5.4	
		C**					5	9	5	2					18.7	21
918.5	Weirton, W. Va.	U.						2	13	6	1				38.6	
		C.							2	11	8	1			93.5	22
894.2	Wheeling, W. Va.	U.			3	7	2								3.8	
		C.					3	7	1	1					16.0	12
732.7	Pomeroy, Ohio	U.				1	10	2	1						9.2	
		C.				1	10	2	1						9.2	14
715.3 + 744.2	Nitro, W. Va.	U.								6	1	4			111	
		C.									3	4	3	1	580	11
661.1	Ashland, Ky.	U.														
		C.					No Data									
630.1	Portsmouth, O.	U.		1	12	5	12								3.8	
		C.		2		1	12	14	1						8.8	30
518.2	Cincinnati, O.	U.				1	2	4							10.7	
		C.						4	3						21.5	7
380.5	Louisville, Ky.	U.			7	12									3.1	
		C.		6	9	2	1	1							2.1	19
372.6	New Albany, Ind.	U.		1	5	5	7								4.0	
		C.		2	8	8									2.7	18
189.4	Evansville, Ind.	U.			2	4	5	2	2	3	2				13.5	
		C.			2	4	5	2	2	3	2				13.5	20
4.5	Cairo, Illinois	U.														
		C.					No Data									
Scioto River	Columbus, Ohio	U.														
		C.					No Data									
Meander Creek	Youngstown, Ohio	U.	7	3											1.0	
		C.	7	0	0	2	1								1.6	10

*Uncorrected
**Corrected

TABLE VII - RESULTS OF THRESHOLD ODOR DETERMINATIONS ON RAW OHIO RIVER WATER AT 30°C. - OHIO RIVER INVESTIGATIONS, NOVEMBER 1950.

Location		Threshold Odor of Raw River Water														
Miles From Mouth of River	Station		Number of Occurrences of Indicated Threshold Odor												Geom. Mean	No. of Determ.
			0	1	2	4	8	16	32	64	128	256	512	1024		
940.8	East Liverpool, O.	U.*	1			8	6	3							5.2	18
		C.**	1					8	6	1					17.4	
918.5	Weirton, W. Va.	U.						4	7	10	1				41.2	22
		C.							1	10	10	1			89.6	
894.2	Wheeling, W. Va.	U.				1	8	7							13.7	16
		C.					3	24	20	5					27.9	
732.7	Pomeroy, Ohio	U.				1	3	4	7						17.5	15
		C.					3	3	7	2					17.5	
715.3 + K44.2	Nitro, W. Va.	U.							1	1	1	3			128	6
		C.									1	4	1		256	
661.1	Ashland, Kentucky	U.			1	4	7	5	1						8.3	18
		C.						2	10	3	1	1	1		46.8	
630.1	Portsmouth, Ohio	U.			4	10		3	3	5					8.7	25
		C.					11	5	4	4	1				16.0	
518.2	Cincinnati, Ohio	U.			1		1	6							11.3	8
		C.				1	1	1	2	3					24.7	
380.5	Louisville, Ky.	U.			15										2.0	15
		C.		6	9										1.7	
372.6	New Albany, Indiana	U.			1	11	7								5.0	19
		C.		1	10	8									2.6	
189.4	Evansville, Ind.	U.					3	11	3	1					17.2	18
		C.					2	12	2	2					18.6	
4.5	Cairo, Illinois	U.		2	13	2	4								2.8	21
		C.				2	1	6	8	4					24.0	
Scioto River	Columbus, Ohio	U.		4	4			3	5						1.4	8
		C.													19.1	
Meander Creek	Youngstown, Ohio	U.	2	7	1										1.0	10
		C.	2	0	2	3	3								3.5	

*Uncorrected **Corrected

TABLE VIII - RESULTS OF THRESHOLD ODOR DETERMINATIONS ON RAW OHIO RIVER WATER AT 30°C. - OHIO RIVER INVESTIGATIONS, DECEMBER 1950

Location		Threshold Odor of Raw River Water														
Miles From Mouth of River	Station		Number of Occurrences of Indicated Threshold Odor												Geom. Mean	Number of Determ
			0	1	2	4	8	16	32	64	128	256	512	1024		
940.8	East Liverpool, O.	U.*	1	1	1	2	4	6							6.6	
		C.**	1	1	1	1	1	4	6						10.7	15
918.5	Weirton, W. Va.	U.						6	5	8	2				39.2	
		C.							5	6	8	2			81.2	21
894.2	Wheeling, W. Va.	U.					3	8	5						17.4	
							1	5	5	5					29.2	16
732.7	Pomeroy, Ohio	U.					1	9	4	6					4.7	
		C.					2	8	3	6	1				28.0	20
715.3+ K44.2	Nitro, W. Va.	U.									3				128	
		C.									2		1		192	3
661.1	Ashland, Ky.	U.				6	4	4	4	1					11.1	
								2	8	1	4	3			24.2	19
630.1	Portsmouth, O.	U.			14	8	2								2.8	
						10	9	5							6.9	24
518.2	Cincinnati, O.	U.			5	2	2								3.2	
		C.			2	2	4	1							5.4	9
380.5	Louisville, Ky.	U.		4	8	2									2.3	
		C.		10	3	1									1.2	14
372.6	New Albany, Ind.	U.			7	10	3								3.5	
		C.		7	9	4									1.8	20
189.4	Evansville, Ind.	U.			1	1	1	4	5	4	2				25.7	
		C.					3	4	3	6	2				32.0	18
4.5	Cairo, Illinois	U.			3	9	1								3.0	
		C.				2	7	8			1				11.8	18
Scioto River	Columbus, Ohio	U.		4	1										2.0	
		C.							4	1					18.4	5
Meander Creek	Youngstown, Ohio	U.		5											1.0	
		C.				4	1								4.6	5

*Uncorrected ** Corrected

TABLE IX - GEOMETRIC MEAN - THRESHOLD ODOR (FINISHED WATER)

Miles From Mouth of River	Station		Sept.	Oct.	Nov.	Dec.	Total Number of Determ.
940.8	East Liverpool, O.	U* C**	1 1	1 1	1 1	1 1	71
918.5	Weirton, W. Va.	U. C.	1.4 4	1.2 2.4	1.1 2.3	1.8 3.7	86
894.2	Wheeling, W. Va.	U. C.	2.3 14	1.7 6.2	7.7 13.3	13.8 30.8	63
732.7	Pomeroy, O.	U. C.	2.8 2.9	2.3 2.3	2.3 2.8	3.0 3.2	71
715.3 + K44.2	Nitro, W. Va.	U. C.	3.3 11.3	10.3 24.2	11.7 20.0	12.7 27.8	34
661.1	Ashland, Ky.	C. C.	- -	- -	1 1.6	1 3.7	37
630.1	Portsmouth, O.	U. C.	1.0 1.7	1 1	1 1	1 1	99
518.2	Cincinnati, O.	U. C.	2.7 3.5	2.4 4.9	1.7 3.4	2.5 4.3	33
380.5	Louisville, Ky.	U. C.	1.4 2.5	1.3 1.5	1.2 1.0	1.0 1.0	68
372.6	New Albany, Ind.	U. C.	2.0 2.0	2.7 2.2	1.7 1.1	1.3 1	67
189.4	Evansville, Ind.	U. C.	45.1 43.6	25 25	16.6 17.8	14.2 17.2	76
4.5	Cairo, Ill.	U. C.	- -	- -	1 1	1 1	39
Scioto River	Columbus, Ohio	U. C.	-	-	1 21	1 16.5	13
Meander Creek	Youngstown, O.	U. C.	2.7 8.0	1.0 3.3	1.0 3.0	1.2 5.3	30

U*= Uncorrected C**= Corrected